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ABSTRACT

To introduce students to the world of robotics and industrial automation, robotics was introduced to students enrolled in electronics classes in the industrial arts program at St. Amant High School (Louisiana). Three robots, three host microcomputers, and necessary software were purchased. The electronics instructor installed the three robots while the host microcomputers were set up by the vendors. Students learned how the basic principles of electronics relate to robotics and had hands-on experience with industrial robots. A total of 134 male students (no females) participated in the program in the first year, at a total cost of approximately $39,090. Students who evaluated the course (124) rated it very highly and stated that they learned about robotics and liked the course. The staff evaluation committee agreed that the project was a great asset to the industrial arts program because it introduced new technology to a program that had not changed in many years. Recommendations for the future included the acquisition of more robots and more microcomputers, upgrading of the equipment as required by technological changes, and one-month extended employment for the teacher to upgrade the program during the summer. The project committee recommended that robotics be added to the electronics courses at other high schools in the district. (A curriculum guide, information about robotics, student activities, and equipment specifications make up a large part of this report.) (KC)

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ASCENSION PARISH

FINAL NARRATIVE REPORT FOR THE EXEMPLARY PROJECT

"ROBOTICS IN INDUSTRIAL ARTS"

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David J. Oubre
Supervisor
Vocational Education

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Date: 11/26/84

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INTRODUCTION

The following is a report of the 1983-84 Ascension Parish "Exemplary Project", Robotics in Industrial Arts, which terminated November 17, 1984.

This narrative report is compiled as stated in the evaluation and dissemination section of the original proposal.

This program was developed and taught under the direction of Duane Dunlap. Mr. Dunlap currently teaches electronics in the industrial arts department of St. Amant High School. The department currently offers to students experiences in an industrial society in drafting, metals, woodworking, and electronics. Mr. Dunlap has seen a strong rise in class enrollment and student motivation. Teaching this aspect of "high technology" has brought students into industrial arts that would have never thought about entering the program before.

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Specific Accomplishments in Relationship to Projected General Goal

General Goal

To introduce students to the fascinating world of robotics and industrial automation. Robotics in industrial arts is being introduced to students enrolled at St. Amant High School in electronics classes.

To bring high technology into the classroom, three robots, three host microcomputers and necessary software were purchased. The electronics instructor installed the three robots while the host microcomputers were set up by the vendors.

The electronics department now includes microcomputers, research robots, electronics trainers, a dot matrix printer, and a variety of software related to robotic literacy. (See Appendix A for Equipment Specifications.)

Specific Accomplishments in Relationship to Projected Objectives

Objective 1

The students will learn and understand the basic precepts of electronics and its relationship to robotics.

The above objective has been met by presenting the following lab activities to the student. The student was introduced to these basic concepts, given both practical and hands-on examples to help make the concepts more concrete.

A. What Makes Up a Robot

B. Robots in History

C. Social Impact

D. Robots for the Future

Objective 2

The student will develop an awareness of current technological advancements and obtain basic electronic and robotic literacy.

In order to achieve this objective, the student was introduced to the basic concept on electronics and its impact on industry and our daily lives.

A. Introduction to Electronics

B. The New Industrial Revolution

C. How Robots Increase Production

D. Careers Associated with Robotics and Education Required

Objective 3

The student will learn problem-solving techniques and the factors involved in robotic programming and circuit design.

This objective was met by presenting instructional units that covered the following topics.

A. History of Robots

B. Effect of Computers on Robots

C. How Robots are Programmed

D. How Teach Pendants are Used

E. Types of Software

F. Types of Hardware

Objective 4

The student will have "hands on" learning experience that will encourage active interest in the electronic industry.

The emphasis was placed on accomplishing this objective because it was felt that as much hands on experience as possible should be presented and was necessary in order to allow the student to develop robotic literacy skills. The student has been exposed to the following:

A. Operate Robot by Computer Controlled Software

B. Operate Robot by Teach Pendant

C. Be Able to Upload and Download Programs from Robots

D. Simulate Real Life Industrial Operation

Objective 5

The student will develop a knowledge of the major components of robotics: Robot fundamentals, A.C. & D.C. electronics, fluidic and positioning power, microprocessor fundamentals, data acquisition, voice synthesis, and microprocessor interfacing.

One third of the program was devoted to the robot mechanics; what makes robots perform their assigned tasks? In order to meet this specific objective, basic robotic fundamentals are being presented:

A. Lab Experiments Concerning:

1. A.C. Electronics
2. D.C. Electronics
3. Microprocessor Fundamentals
4. Data Acquisition
5. Voice Synthesis
6. Microprocessor Interfacing

Objective 5 (cont'd)

B. Theory Concerning Robotic Control and Movement

1. Electro Mechanical
2. Hydraulic
3. Pneumatic
4. Any Combination of These

Objective 6

The student will develop the personal traits and technical skills needed by educated personnel to design, specify, sell, program, operate, and service robots.

The student was presented an overall view of the role robots play in industry as well in space, farming, military operations, and social occasions. The education, training, and skills needed by the student to enter this exciting field of high technology was also covered.

A. Visit University Industrial Technology Departments to see their computer aided manufacturing facilities.

B. View video tapes from industry on robotic applications.

C. Be able to write specifications concerning the characteristics of each type of robot.

D. Be able to trouble shoot robot malfunction by either hardware or software failure.

Statistical Data

The following is a statistical breakdown of the students who came in contact with the pilot programs this year:

Total Number of Students	134
Total Number of Male Students	134
Total Number of Female Students	0
Total Black Students	3
Total White Students	131
Total Handicapped Students	0
Total Disadvantaged Students	71

Financial Report of Expenditures

Federal Project Expenditures	
Equipment -- Robots and Computers	$ 17,950.82
Software	911.06
Other -- Telephone	132.97
	$ 18,994.85

Local and State Expenditures	
Supervisor Salary - 5%	$ 1,707.60
Teacher Salary -- 100%	15,656.00
Retirement of Personnel	1,604.28
Personnel Insurance	633.67
Office and Printing Expense	100.00
	$ 19,701.55

REQUEST FOR REIMBURSEMENT TO THE
OFFICE OF VOCATIONAL EDUCATION
STATE DEPARTMENT OF EDUCATION

FORM VE-200 DETAIL

1983-84
Fiscal Year

DAVID J. DUBRE
ASCENSION PARISH SCHOOL BD.
P. O. BOX 189
DONALDSONVILLE, LA 70346

State of Louisiana
Department of Education
OFFICE OF VOCATIONAL EDUCATION
Post Office Box 44064, Capitol Station
Baton Rouge, Louisiana 70804

Ascension Parish School Board
Applicant (Legal Name of Agency)
INFORMATIONAL DATA AND LOCAL EXPENDITURES

For Each Vocational Progra

Exemplary Project--Robotics in Industrial Arts

Vocational Education

Page 1 of 1 Page(s)

D. J. O

All of the Federal money awarded for this project was used to purchase robots, computers, and software.

1. Name of Vocational Teacher	2. 9 Months Salary Including State and Local Funds	3. Teacher Retirement	4. Pro Rata Time Voc. Subj.	5. 9 Months Vocational Salary (Col 2+3x4)	Extended Employment 6. Salary	Extended Employment 7. Retirement	8. Adult Class Salary	9. Teacher Aide	10. Total Vocational Salary (Col. 5-9)	11. School	12. Vocational Travel	13. Vocational Supplies	14. Other	15. Vocational Equipment
										St. Amant		911.06	132.97	17,950.82
GRAND TOTAL	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX									XXXXXXXXXXXXXXXXXX		911.06	132.97	17,950.82

Total Local Expenditures (Add Columns 10, 12, 13, 14, 15) $ 18,994.85
(To Be Completed by Louisiana State Department of Education)

Page _____ of _____ Page(s)
PART _____

Expenditure Item	Total Local Expenditures	Reimbursement
1. Salary & Retirement (Column 10)	$	$
2. Travel (Column 12)		
3. Supplies (Column 13)	911.06	911.06
4. Other (Column 14)	132.97	132.97

Expenditure Item	Total Local Expenditures	Reimbursement
5. Sub-Total (1 - 14)	$ 1,044.03	$ 1,044.03
6. Indirect Cost: Rest. Rate ____	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
Unrest. Rate	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
7. Equipment (Col. 15)	17,950.82	17,950.82
8. Total	$18,994.85	$18,994.85

Section Chief/Director, Vocational Education

DATE

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Results of Evaluation by Students

An evaluative instrument was developed to be issued to students enrolled in the Electronics/Robotics program. (See Appendix B.) The results of the evaluation by students are given in percentage of responses. One hundred twenty-four students were involved in the evaluation responses.

		Yes	No
1.	Are you learning and developing an understanding of the basic precepts of robotics and their relationship to computers?	98%	2%
2.	Did you learn problem-solving techniques and factors involved in decision making?	94%	6%
3.	Did you develop an awareness of current technological advances in industry?	99%	1%
4.	When using the robots in the industrial arts laboratory, did you gain an interest for higher technology?	100%	0%
5.	Are you gaining a working knowledge of automation and robotics in general?	97%	3%
6.	Do you feel you have developed a knowledge of the major components of robots in the industrial work place?	82%	18%
7.	Do you feel industrial arts in general needs to incorporate other high technology areas such as robotics into other programs?	100%	0%
8.	Is one period (50 minutes) long enough to work on this important consideration of industry?	5%	95%
9.	By being involved in industrial arts and working with robots, do you feel this has increased your chances in education?	99%	1%
10.	Would you recommend taking this course to other students?	88%	12%
11.	Did you like this course?	97%	3%

12. What do you think should be changed or added to the robotics in industrial arts course in order to make improvements?

A summary of the comments for Question 12 is as follows:

A. More robots to lessen students to robot ratio
B. Textbook that incorporates robotics
C. More microcomputers
D. More available software for students

Staff Evaluation Report

The Staff Evaluation Committee, consisting of the vocational supervisor the school principal and the teacher, met to evaluate the project in order to make recommendations for the improvement of the program and possible expansion of the program to other schools.

It was the general concensus of the group, that the project was a great asset to the industrial arts program by initiating new technology to a program which had not changed in many years.

This project provided the chance for the school to follow the guidelines established by the American Industrial Arts Association for teaching the true meaning of industrial arts. The interest and motivation of the students was very high which caused an increase of enrollment in the program. This interest also carried over into other curriculum areas.

The committee made the following recommendations:

Two additional robots should be added to the program.

Three more microcomputers should be acquired.

Provisions should be made for the upgrading of the equipment as technology changes.

One month extended employment should be provided for the teacher during the summer to upgrade the program.

The committee agreed that the program should be added to other schools when electronics is added to the curriculum.

Assessment of Strengths and Weaknesses

Strengths

A. Students are highly motivated working with robots and putting computers to work in a three-D sense.

B. The amount of interest generated by this project has carried over into other curriculum areas.

C. Recognition from local, state, and national organizations for excellence in education has been a motivating factor for teachers and administrators.

D. The project followed guidelines recommended by the American Industrial Arts Association for teaching the true meaning of Industrial Arts.

E. A telephone in the electronics department to aid in solving technical problems is a great asset.

F. Excellent support from the vocational supervisor's office and school principals.

Weaknesses

A. A board based electronics book that covered robotics or Computer Aided Manufacturing is not available.

B. More time is needed for technical set up and preparation.

C. No curriculum guide in the nation has yet addressed robotics, robotic literacy, in depth for high school students.

D. A special allotment for purchasing additional software and equipment is not available.

Recommendations for Future Approaches in the Local System

A. Limit the number of vendors who supply computers and perpherials.

B. One month extended employment for teacher (set up robots, assorted paperwork, classroom materials, jigs, and fixtures, etc.)

C. Acquisition of two more educational robots.

D. Acquisition of three more microcomputers.

E. Acquisition of a plain paper copier to help in the dissemination of the vast amount of handouts and technical information.

F. A sincere provision of both short and long range plans that would include the upgrading of the equipment in the classroom.

ROBOTICS CURRICULUM GUIDE

I. Introduction to Robotics

A. General Overview of Robots Past - to Present - to Future

B. Social Impact and Labor

C. Manufacturing and Manufacturing Operations

1. Production and Productivity
2. Automation

D. Robot Definition

E. Robot Classification

F. Robotics Terminology and Nomenclature

II. Computers for Learning/Programming/Control

A. Microcomputer Operating Systesm Orientation

B. Computer Languages - Introduction/Review

1. Hi Level/Low Level
2. Basic Computer Language
3. Robotic Language Programming

C. Computer Number Systems

1. Decimal
2. Binary
3. Hexadecimal

D. Microprocessor Based Control

1. Machine Language Programming
2. Control and Interface

III. Robotics Trainers and Training Equipment

A. Rhino Robot

1. Teach Pendant
2. Computer Control

B. Introduction/Operation Exercises

1. Demonstration
2. Familarization
3. Programming Exercises

C. Microbot Teach Mover

1. Stand Alone
2. Host Computer
3. Programming Exercises
   a. Pick and Place - Plastic Cubes
   b. Pouring Water Between Cups

D. Heathkit HERO-I

1. Robot Operating System
2. Voice Synthesizer
3. Sonar Detection
4. Sound Detection
5. Light Detection

IV. Electronics Module

A. Basic Electricity/Electronics Fundamentals

B. D.C. Circuit Analysis/Use of Meters

1. Electrical Quantities
2. Use of the V-O-M Multimeter

C. Alternating Current Fundamentals

D. Microprocessor Fundamentals

V. Hydraulic/Pneumatics Module

A. Principles of Hydraulics

1. Compression of Fluids and Air
2. Pascal's Law
3. Hydraulic Actuators
4. Comparison of Hydraulic and Pneumatic Systems

B. Hydraulic Components and Circuits

C. Pneumatic Systems

VI. Physics Module

A. Introduction of Terms, Concepts, and Formulas

1. Matter and Energy
2. Motion, Velocity, and Acceleration
3. Force, Work, Energy, Power, and Efficiency
4. Balanced and Parallel Forces
5. Torque and Friction

VII. Manufacturing/Robotics - Automation

A. Robot Justification - Cost Effectiveness

B. Robot Applications

1. Assembly
2. Materials Handling
3. Machine Loading
4. Welding
5. Die Casting and Plating
6. Forging, and Heat Treating Operations
7. Painting and Finishing
8. Machining Operations
9. Part Sorting
10. Inspection and Quality Control
11. Quality Assurance

C. Implications for Robotics in Industrial Arts

1. Need
2. Cost
3. Operations
4. Simulations
5. Student's Impact on Learning a Segment on "High Tech"

VIII. Student Activities

ROBOTICS: AN INTRODUCTION INTO THEIR USES IN INDUSTRIAL ARTS

BY: DUANE D. DUNLAP

INTRODUCTION TO ROBOTICS

Robots are part of automated systems within existing manufacturing processes, making the robot a very important part in the industrial work place. The study of robotics is, by nature, interdisciplinary. Concepts and applications can be incorporated into many industrial arts programs. The introduction of robots into the mainstream of American industry will have a great impact on those involved in industrial arts education.

Even though robotics has gained much recognition as a high technology area, it is hard justifying it as a "stand-alone" program. Robots and their interaction with computers, are essentially tools that are utilized in many segments of manufacturing industries.

Industrial arts educators teaching a laboratory course in manufacturing, power and energy, communications, or for that matter, plastics, graphic arts, metals, electronics, or wood technology will want to introduce students to industrial robotics. Students need to be aware of the changes being brought about by automation in industry. All over the world public schools, technical schools, colleges and universities, research organizations and institutes are examining the involvement of robot technology in manufacturing, construction, medicine, agriculture, and space exploration.

What is an Industrial Robot?

The word robot came into use as recently as 1921 in the play, R.U.R. by a Czechoslorakian author named Karel Capek. Robot is the Czech word for "worker". R.U.R. stood for Rossum's Universal Robots, which applied to manufactured mechanical beings that performed manual work for humans.

Unlike androids, industrial robots are not designed to resemble humans, and "robot" now refers to any machine that performs jobs previously performed by people. The Robot Institute of America defines a robot as "a reprogrammable multifunctional manipulator designed to move material, parts, tools, or specialized devices, through variable programmed motions for the performance of a variety of tasks". Simply put, a robot is a machine that can perform many jobs a person can, plus does it faster and more consistently with less scrappage and rejection, doesn't take vacations, go on strike or require fringe benefits, and can be switched to another task without extensive retraining. It can perform in an environment that humans find uncomfortable and do repetitive jobs without getting bored or losing interest.

Types of Robots

There are three general classifications of robots: (A) the nonservo controlled, (B) the servo controlled, and (C) the remote controlled.

A. Nonservo controlled robots are the simplest and least expensive. Sometimes they are referred to as: open-loop, end-point, pick-and-place, limited sequence or fixed sequence. This type of robot is usually limited to only two positions along each axis. The robot is only capable of moving from one endpoint to the other, where it is physically stopped in a desired position. A common characteristic is that it has no capacity to respond to changes in the manufacturing environment. This class of robots may or may not be programmable. Nonservo controlled robots share the characteristic that they operate without sensors and are working blindly. These are also referred to as low-technology robots.

B. The second type of robot is servo controlled. It may be referred to as decision making, sensory, intelligent, or environmentally adaptive. Medium-technology robots use controlled mechanisms such as microprocessors or micro-computers as control. This type of robot has the description of having a closed loop system. Feedback information is fed into the control unit, which compares the feedback information with values already placed in the control system. Whenever the values being fed back violate established parameters, or match established values the control unit will respond by taking actions which have been preprogrammed. This way, the robot becomes some what sensitive to the environment in which it operates and is able to optimize productivity, eliminate error and minimize the possibility of damage to the tool, product or user. Servo controlled robots can stop and start at any point within the work envelope of the robot.

C. The third class of robot is the remote controlled robot. This can involve both stationary and mobile robots. The most commonly used types are master-slave units, teach penant control units, or radio controlled robots. These variations are normally found where real time control by a human is desired, in an environment which the human cannot function. They are also used where a robot needs to be controlled over great distances.

Parts of an Industrial Robot

Basically, robots consist of three major components: (A) the manipulator, (B) controller, and (C) the power source.

A. The manipulator or "mechanical unit" actually performs the work. It is a series of mechanical linkages and joints that provides movement in any number of degrees of freedom. The industrial robot must be able to reach the machine it is serving or work piece it is handling.

The robot's work envelope (work area) is based upon its ability to deliver the end effector (hand configuration) to specific locations in order to carry out the assigned task. The end effector or gripper of today's industrial robots is one of the major drawbacks in robot utilization due to the lack of hand programmability. This is one the weakest links of robot components. Robot arms generally include the following types. (See Figure 11-8 for more detail)

1. Revolute arms can both bend at the shoulder and elbow. These robotic arms are the most flexible and do represent some human characteristics. Spray painting would be a common application of this robot.

2. A Cylindrical Coordinate Robot consists of two basic parts, a horizontal manipulator mounted on a vertical column. The vertical column, then, is mounted on a rotating base. The arm can move horizontally out from the pole, swivel around it, and move vertically up and down along the pole.

3. A Polar Coordinate Robot has an extendable arm mounted on a central pivot. Instead of moving up and down like a cylindrical arm, the polar robot moves so that the work envelope forms the outline of a sphere to reach out above or below the level at which it is mounted. An example of a polar robot would be spot welding of auto parts.

4. Cartesian arms are based on a linear axis motion, these linear axis are know as x, y, and z. This configuration gives the robot's arm and gripper great accuracy and makes it slow. This system can be used effectively for tasks such as loading and unloading machines.

B. The controller, or brain of the robot, has three primary functions. They are (1) to control the motions of the manipulator, (2) to store program data in memory, and (3) to interface with the equipment with which the robot interacts. The controller has two basic components the hardware (computer) and the software (task programs).

C. The power source provides energy for the manipulator's actuators. It is dependent on the type of actuator used. An actuator is a motor, cylinder, or some kind of mechanism that converts one form of energy into another. Actuators can be electrical, pneumatic, hydraulic, or any combination of these.

1. Electrical actuators represent about 50% of all actuators available today. They include stepper motors, pluse motors, and dc servo-motors. Electric drives are in smaller robots where accuracy is important.

2. Small and big robots that move around large payloads use electro-hydraulic actuators which comprise 35% of all actuators used in robots. A hydraulic actuator converts forces from high pressure hydraulic fluid into mechanical shaft rotation on linear motion. Hydraulic robots are used to load and unload machines and to perform repetitive operations such as spray painting and welding.

3. The simplest type of actuator is the pneumatic actuator which is used in about 15% of robotic applications. Pneumatic robots typically are limited to light-duty applications involving the transfer of parts weighing less that 50 pounds. Pneumatic robots are cheaper in operation that the other methods.

End Effectors and Grippers

The end effector is the action end of the robot. It may be a spray painter, welder, screwdriver, a hook, vacuum cup, electromagnet, a thin platform or spatula, a mechanical gripper, or even a pneumatic bayonet socket type. Depending on the capacity of the computer controller, it can be a highly sophisticated robot fitting. Grippers come in all shapes and sizes, many are custom made for a particular job or handline assignment. Whether a robot is an industrial or teaching type, if it's redeployed for a different task or an entirely different process it is likely that the hand tooling has to changed. See Figure 11-9 for more description.

Robot Applications - Industrial

Most robots in the United States today are used in welding (36%). With the increase in robot applications, machine loading and unloading along with foundry both have 20% of the robot population in the U.S. Painting ties up 13%, education and research 10%, and assembly approximately 1%. The following U.S. industries utilizing robots in 1982 are ranked in order: 1. Automobile 2. Electric Machinery 3. Plastic Moulding Products 4. Metal Working 5. Iron and Steel and 6th is the Electronics industry.[1]

Robot Applications - Industrial Arts

Industry is being interjected with computer aided manufacturing equipment such as robots. Industrial arts offers all students experiences for life in an industrial and technological society, it should therefore, interject its subject matter with robots.

One of the first examples that comes to mind would be both arc and spot welding. The basic equipment is almost usually there in an industrial arts department. The best part is the creative utilization of the robot application to the welding process. All that is needed now is for the classroom/laboratory teacher to tie the process and automated application together.

Robot applications in industrial arts are really limitless, (a) machine loading and unloading, (b) drilling sequence, (c) electronic component assembly, (d) line production activities such as finishing process, material handling, assembly and quality control, (e) research and development activities, and (f) casting processes such as pouring, shake-out, and mold venting. The list can go on and on with applications that industrial arts educators and students can discuss. One point that should be emphasized is that the machines are not the point, the process is.

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[1] (Robot Institute of America)

In the classroom, drilling holes in wood with robots is not the point. The point is what we are learning is what has to go into the process, the methods behind any application.

A good basic foundation in robotics requires knowledge of a number of industrial areas which are usually already taught in industrial arts. A team-teaching approach is one solution to imparting sound coverage of the material. For example: the automotive instructor could teach hydraulics; the heating, and air conditioning instructor could teach the pneumatics; the metals shop instructor could teach machine gears and mechanical systems; and the basic electricity, electronics and computer applications could be taught by the electronics instructor or someone else at your school with a background in this area. The student does not need any knowledge of programming.

Students could bring in articles to put on a bulletin board to share ideas and raise interest and discussion. Students can identify robot applications during their laboratory activities.

What Cybernetics Mean to Industry

The primary importance of robotics in the future is that it will be changing occupational patterns. Currently robots are being used to assume low-level manipulative occupations and jobs that are health hazards. One could say that the robot is envisioned to be a perfect worker who performs repetitive tasks 24 hours a day without breaks, light, and heat in hazardous environments at a cost of about $7.50 per hour.

Productivity will also be effected by robotics. The price of computer power has decreased by a factor of two each year for the past 20 years. The robot works without becoming bored, hungry, fatigued, and in environments which are hostile to human beings. Robotics will require industries to re-think the design of products, production lines, work stations, and the relationship between man and machine systems.

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Periodicals for Robotic Information

Robotics Age: The Journal of Intelligent Machines.

Published every month, this journal provides the best source of information and for anyone interested in do-it-yourself robotics and robots in general. Articles range from discussion of sophisticated computer algorighms to construction articles on inespensive robot equipment. New product reviews and reports on robots in the media round out a fine publication. Cost: $21/yr. for 12 issues.

Robotics Age
Box 358
Peterborough, NH 03458

Robotics Today.

Published six times a year by Robotics International of the Society of Manufacturing Engineers, Dearborn, Michigan, this trade journal carries articles of interest to manufacturing engineers and managers involved in robotics. Actual industrial applications are featured in many of the articles. Also included are items about new products and equipment for the robotics industry. Cost: included in RI/SME membership of $36/yr for nonmembers.

Computerized Manufacturing.

General news pieces on robotics, CAD/CAM and automation. Includes updates to the Intelligent Factory Library. Cost: $15/yr. for 6 issues.

Technical Database
P.O. Box 720
Conroe, TX 77305

The Industrial Robot. Quarterly, International Fluidics Services, Ltd., Carlton, Bedford, England

Robot. Quarterly, Japan Industrial Robot Association, Tokyo, Japan

Omni. Monthly, Omni Publications International, Ltd., New York

High Technology. Bi-monthly, Technology Publishing Co., Boulder, Colorado

Popular Science. Monthly, Popular Science, P.O. Box 2874, Boulder, Colorado 80321

Reference Books on Robotics

1. Albus, J.S. Brains, Behavior and Robotics. New York: McGraw-Hill, 1981.

2. Ayres, R.V. The Impace of Robotics on the Workforce and Workplace. Pittsburgh: Carnegie-Mellon University, June 1981.

3. Dorf, Richard C. Robotics and Automated Manufacturing. Reston, Virginia: Reston Publishing Company, Inc., 1983.

4. Engelberger, Joseph F. Robotics in Practice. American Management Association, 1980.

5. Dent, Ernest W. The Brains of Men and Machines. Peterborough, NH: Byte/McGraw-Hill, 70 Main Street, 1981.

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7. Krasnoff, Barbara. Robots: Reel to Reel. New York: Acro Publishing Co., Inc., 1982.

8. Paul, Richard P. Robot Manipulators: Mathematics, Programming, and Control. Cambridge, Mass.: The MIT Press, 28 Carolton Street, 1981.

9. Susnjara, Ken. A Manager's Guide to Industrial Robots. Dale, Indiana: Thermwood Corporation, P.O. Box 436, 1982.

10. Fanner, William R., (Ed.) Industrial Robots. Dearborn, Michigan: Society of Manufacturing Engineers, 1977.

Audio-Visual Materials

A. Robot Institute of America
P.O. Box 930
Dearborn, Michigan 48128
(313) 271-1500

Video Tape Series

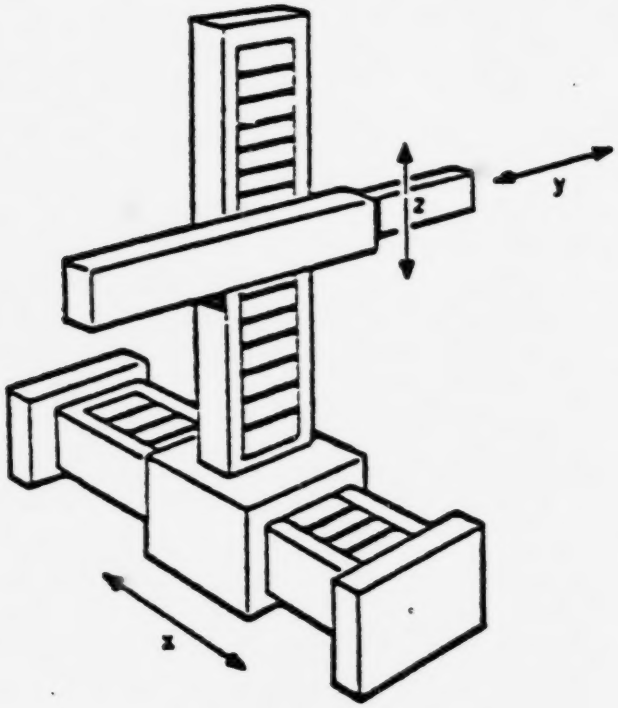
1. The Industrial Robot . . . An Introduction
2. Industrial Robot Applications

16 mm Films

1. Command Performance
2. General Electric Manmate 2000
3. Unimation Robots for People Who Think
4. Computer Controlled Robot Assemble of Automobile Alternators
5. Hierachical Control (Computer Controlled Robot)
6. Cincinnati Milacron 6CH Arm Robot
7. Olivetti Company Robot
8. Prab Robots in Industry
9. The DeVilbiss-Trallfa Robot

B. Science Media
P.O. Box 910
Boca Raton, Fla. 33432
(305) 291-0332

ROBOT COORDINATES



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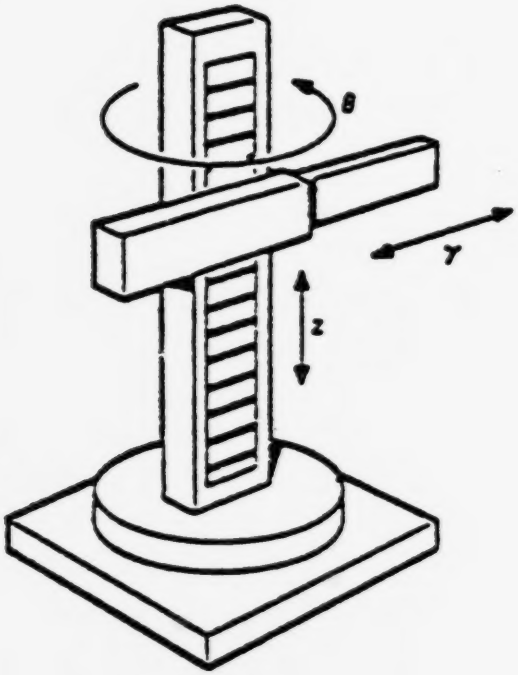

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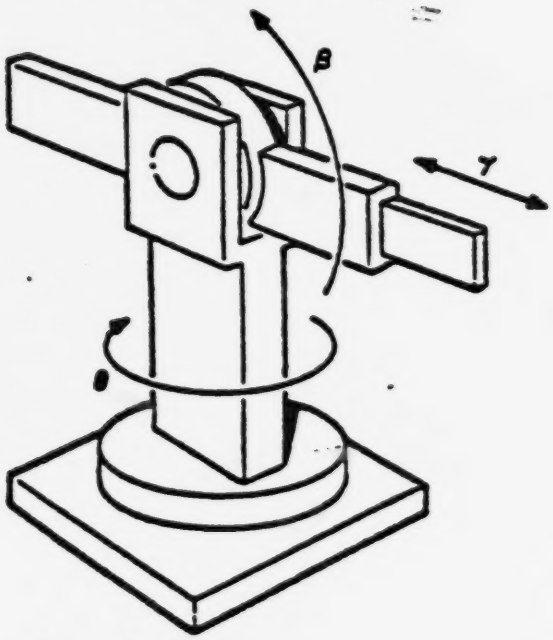

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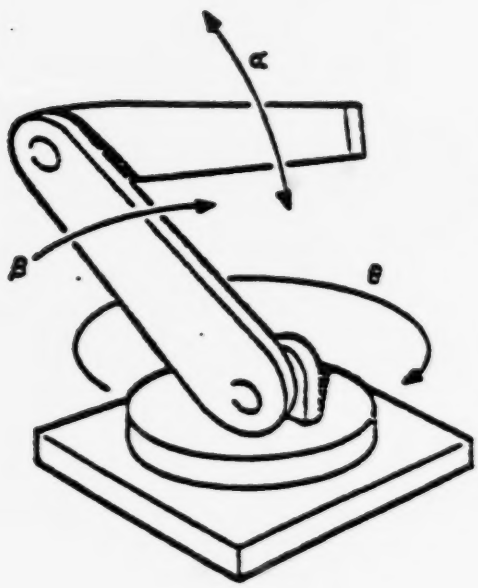


REVOLUTE COORDINATES

Figure 11-8

(Courtesy Robot Institute of America)

End Effector

The end effector is the device that performs the actual work. An end effector can be a simple gripper type of mechanism or a special tool fitted to the robot's wrist assembly. Figure 11-9 shows some of the end effectors currently being used in industry.

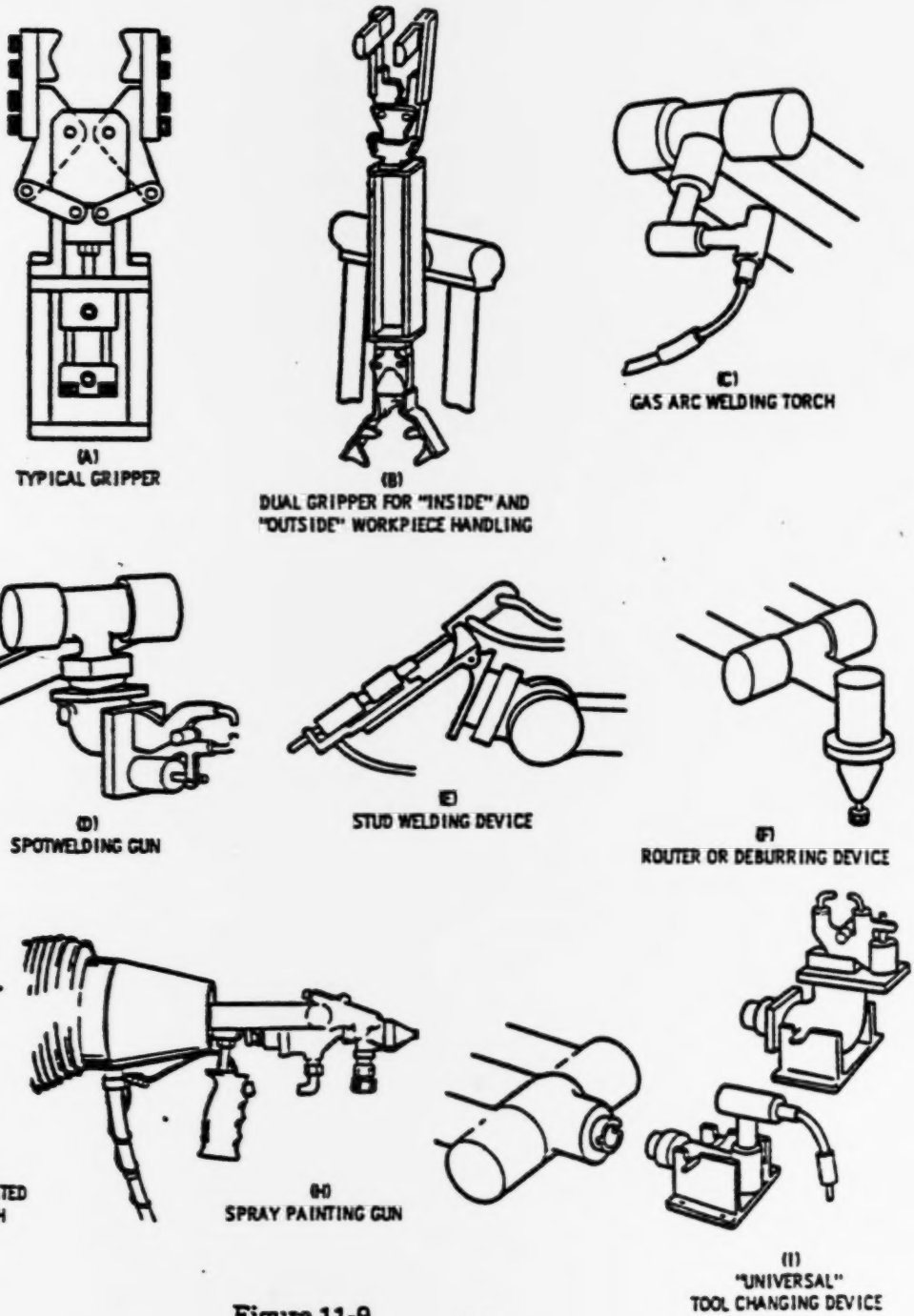
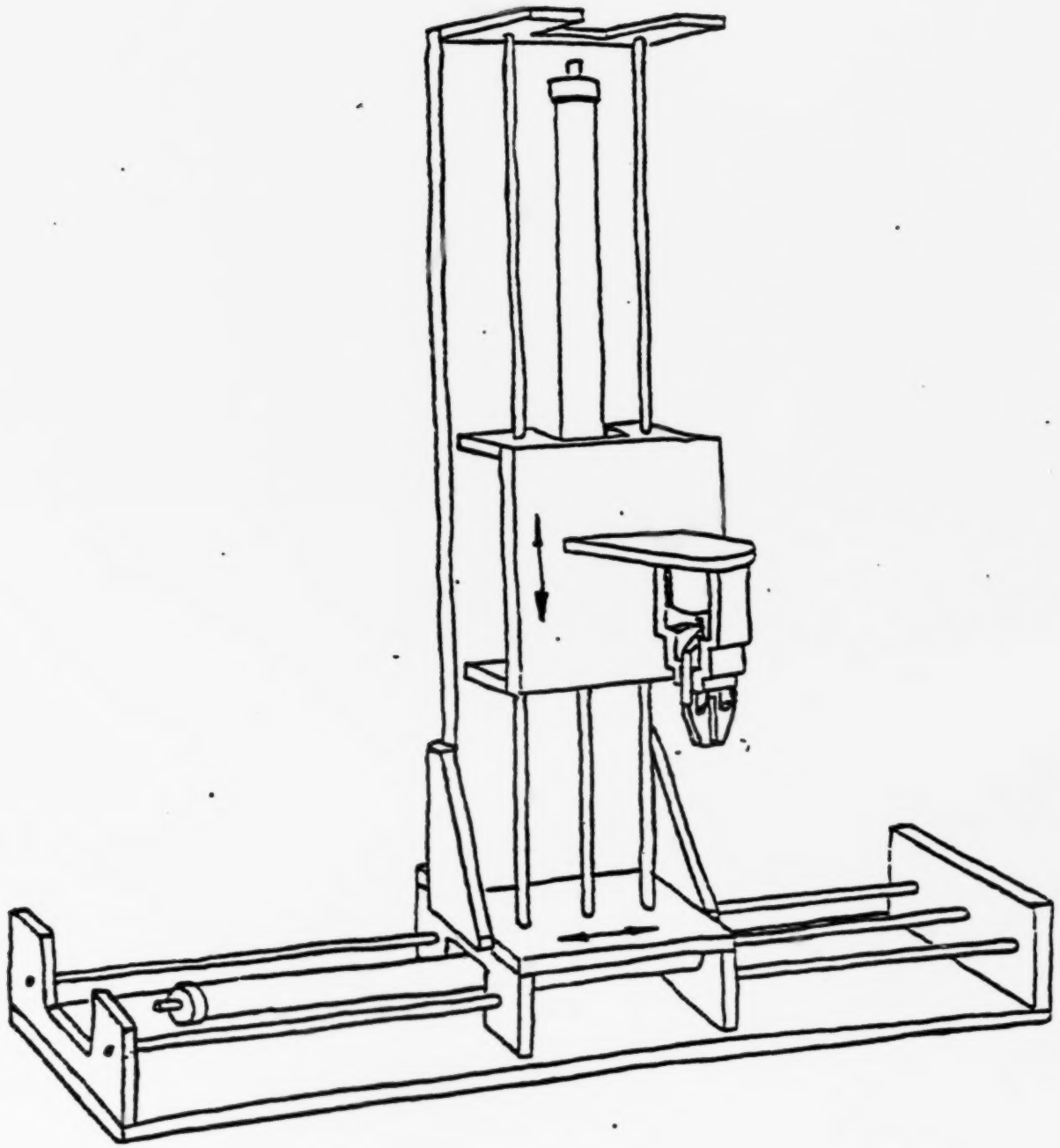


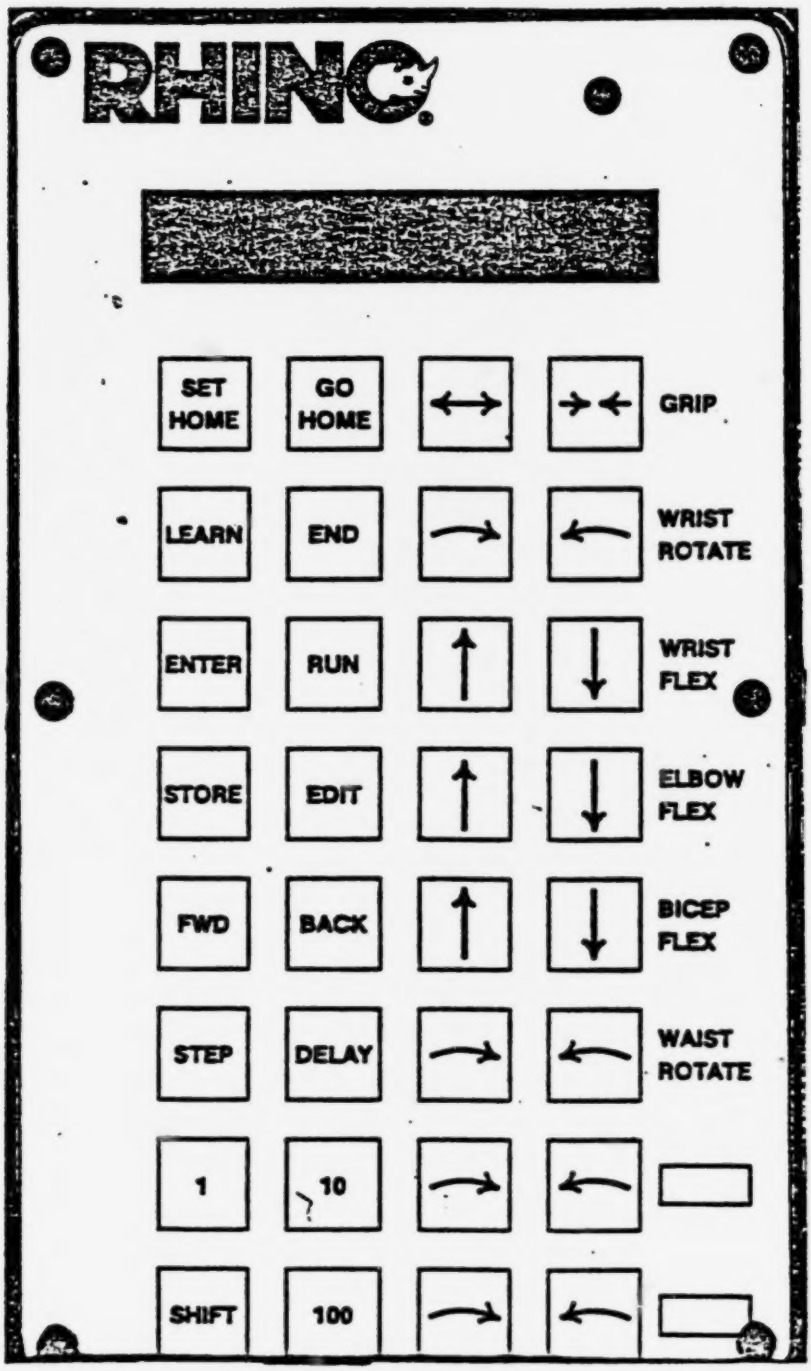
Figure 11-9

(Courtesy of Heath 1984)

General Electric
"ROBOT CONCEPTOR"
for
Industrial Arts
(pneumatic driven)



Typical Teach Pendant



(Courtesy of Rhino Robots 1983)

STUDENT ACTIVITIES

Module 1	Introduction to Robotics
Module 2	Types and Parts of a Robot
Module 3	Applications of Industrial Robots
Module 4	Operations of Drive Systems on Robots
Module 5	Using Robot Teach Penants

Introduction To Robotics

This mission you are about to accept, is for you, the student to get a good understanding of robot parts, their abilities, and applications. Selected readings from each of the robot operation manuals must be read in order for you to get a thorough understanding of robotics and become familiar with the particular robot you are reading about. Each student will complete the module by: 1. Reading the assignments, 2. Complete lab activities, and 3. Take a written quiz over information and processes presented in 1 and 2.

It would be a good idea to take notes of important concepts and technical information that will be useful to you in operating any of the three robots. Readings and lab activities will be done on all three robots, so don't get the idea that you are only going to be working with one robot. The following learning objectives are ideas and concepts that you need to be aware of while reading. Good Luck!

Student Learning Objectives

At the completion of this module, the student must be able to score at least 80% on the unit quiz, by completing the reading assignments and lab objectives before moving on.

1. Be able to write a working definition of a robot and describe where the word "robot" came from.

2. Describe the difference between an android and a robot.

3. List benefits that industry gets when robots are used in the work force.

4. Know each of the five Industrial Clusters that are using robot technology.

Student Reading Assignments and Lab Activity

1. Robot Fundamentals. Unit 1. Robotics and Industrial Electronics, Heath Kit. Pages 1-2, 1-3, 1-6, 1-7, 1-8.

2. Introduction to Robots and Robotics. Section Six. Rhino XR-1 Operating Manual.

3. A Brief History of Robotics. Appendix A. Microbot User Reference Manual. Pages A.1 (Master-Slave Manipulators) and A.8 (Industrial Robots).

4. Take a close look at all three robots in the lab, list similarities of your arm to the robots.

	My Arm	Robot
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

5. What applications in industrial arts labs, could use robots to do a task? What kind of tasks come to mind. Put these at a later point.

Types and Parts of a Robot

Student Learning Objectives

At the completion of this unit, the student must be able to score at least 80% on the unit quiz, before moving onto the next one.

1. List the five basic characteristics that define the capabilities of a robot.

2. List and describe the major structural components of the Teachmover, Rhino, and Hero.

3. Be able to: list robot manipulator arm types, the three functions of the controller, and the types of energy sources used by a robot's actuator.

4. What are the general classifications of robots and a common characteristic of each.

5. List at least six different types of end effectors and what they might perform in a "work envelope".

Student Reading Assignments and Lab Activity

1. How the Teachmover is Built. Teachmover User Reference Manual. Pages 3.1 through 3.15.

2. How the XR-1 was Born. Rhino User Manual Section Seven.

3. Robot Capabilities and Limitations. Robotics and Industrial Electronics by Heath Kit. Sections 1-9 through 1-21.

4. Parameters of the Rhino System. Rhino User Manual Section Eight.

5. List similar robot parts, end effectors, and classifications that are common with all three robots in the lab.

Applications of Industrial Robots

The purpose of this unit is to get an understanding of what goes on in the industrial workplace using robots.

Student Learning Objectives

At the completion of this module, the student must be able to score at least 80% on the unit quiz, by completing the reading assignments and lab objectives before moving on.

1. Be able to list major industries using robots.
2. Describe applications robots are doing in the industrial work place and processes for the future.
3. Be able to list characteristics of low, medium, and high technology robots.
4. List factors that would support the statement, Why use a Robot?
5. After viewing robot videotape, be able to note, what working conditions robots are used in.

Student Reading Assignments and Lab Activity

1. Robots and Industrial Electronics, Heath Kit. Pages 1-22 through 1-46, and Unit 11
2. Industrial Robots. Microbot User Manual. Appendix A Pages A.8 through A.11
3. Robot Applications. Robotics and Industrial Electronics (blue binder) Pages 1-14 through 1-37
4. View both film strip and videotape on Industrial Robots.

Operations of Drive Systems on Robots

This unit deals with getting to know how stepper motors work, modes of operations on the robots, and operating specifications for the Teachmover, Rhino, and Hero.

Student Learning Objectives and Lab Activity

1. Be able to list the different types of motors used in robot manipulators.
2. Characterize stepper motor operation and speed considerations.
3. Be able to list operating modes, for example on the Hero.
4. Describe what is meant by "initializing home".
5. List different specifications and limits of operating systems in the Teachmover, Rhino, and Hero.

Student Reading Assignments and Lab Activity

1. How the Stepper Motors Operate. Microbot User Reference Manual. Chapter four, pages 4.1 through 4.10.
2. Operation of Motors. Rhino Operation Manual. Section 13.
3. Modes of Operation. Hero User's Guide. Pages 17-24.
4. Specifications. Hero Technical Manual. Pages 7-8.
5. Instructor will demonstrate working envelope of each robot.

Using Robot Teach Penants

In this module, you the student are going to become fimilar with operating the robots by using the teach pendant. This will be the first time you will operate the robots. You will become fimilar with the control functions on each of the robots teach pendants. You will need to draw each teach pendant on a separate piece of paper and label the drawing throughly. Also take note and write down the function of each key. If at any time, you are unsure about operation of the teach penant, STOP and ask the instructor for help. If this condition is not followed, serious damage could result to the robot. This in turn could be irreversable. Take your time, read everything throughly, take good notes, ask questions, and make sure you have the teach penant operation under control before you operate the robot.

Student Learning Objectives

The student must be able to complete the unit quiz with at least a score of 90% before operating robots. This can be accomplished by completing student reading assignments and objectives.

1. Be able to list and describe control functions on each robot teach pendant.
2. What is meant and the purpose of "home position".
3. What are the Modes of Operation on each teach pendant; Teachmover, Rhino, Hero.

4. List each step you would have to complete to save a teach pendant program (all three robots).

5. What steps are required in each robot to run a teach pendant program.

6. Now, once you feel confident with the above material, complete unit quiz before operating robot.

Student Reading Assignments and Lab Activity

1. Operating The Hand-Held Teach Control. Microbot Teachmover Reference Manual. All of Chapter Six.

2. Teach Pendant XR Series Support Hardward, Version 1.0 Rhino User Technical Binder. Pages 1-9.

3. Modes of Operation. Hero Robot User's Guide. Executive Mode (reset). Page 21 through Repeat Mode A, Page 24.

4. Complete demonstration program on Teachmover, page 6.30.

5. Save and run a 10 move sequence on the Rhino.

6. Remove Hero from the table, save and run program on moving from the lab sink to the door and back.

Comments: When beginning robot operation, do not over extend capabilities of robots, example - run arm into table top, run Hero into obstructions. Lift more than one pound with each robot, or continually push stepper motors functions as this will over heat and due permanent damage to motors.

APPENDIX

EQUIPMENT SPECIFICATIONS

1 ea. Hero I Robot by Heathkit
ETW; Complete with #EE-1800 Robotics Course, #ET-18-4 Deno ROM Chip, #EE-1812 Robotics Applications

1 ea. RINO XR Mark II Robot;
Complete with Manual, Teach Pendant System, Interface Cable from RINO to Computer, Rasp IA Software with Super Serial Card A2B004, Rasp 3A Software, Linear Slide Base, FMD Moto-Dremel Holder

1 ea. Teach Mover Robotic Arm;
Includes teach control, power supply 110 vac, user manual and tutorial.

Complete with the following accessories:
Teach Mover Accessory Expansion
Teach Mover Experimenter's Kit
End Effector Attachment Flange
Teach Mover Carrying Case

1 ea. Microcomputer System Unit; Franklin Ace/1200 System with the following specifications:

a. Ace 6502 Microprocessor operating at 1.02 MHZ and a Z80 Microprocessor operating at 6.00 MHZ (CP/M mode)

b. 64K of RAM in the basic machine plus an additional 64K on the CP/M card

c. Total memory of 128K bytes of RAM, 250 ns of access time and six sockets of 12K EPROM

d. Two built-in disk drives that contain 256K of storage per disk, 48 tpi single-sided disk, 300 RPM, 5¼" standard desk size.

e. Keyboard including min. 72 keys with numeric pad, reset, upper and lower case, auto-repeating key, 80 column card

f. Built-in cooling fan with line surge protector

g. Disk controller serial/parllel interface

h. Built-in RS232C serial interface, centronics compatible parallel interface, joystick with paddle connector and 8 peripheral board connectors

1 ea. DVM II card installed in Item 1 to use Item 4 Color Monitor

2 ea. Monitor; AMDEK 300 Model No. V3006 12" Green Screen with the following specifications:

a. 12" diag., 90 deft angle, composit video

b. Resoluation center 960 lines, corner 800 lines

c. Play-color monochrome

d. Video cable for each monitor to be installed with item 2

1 ea. Matrix Printer, Prowriter I No. 8510AP with the following specifications:

a. 10" carriage' 8" max. print width

b. 80 columns

c. 120 characters per second

d. Uni-directional and bi-directional print directions

e. Chracter spacing; pica, compressed font, elite, proportional

f. Line spacing variable to 1/144"

g. Tractor or friction feed

h. Cartridge type ribbon

i. Minimum 1K buffer

j. Graphics capability

k. Automatic vertical and hroizontal

1. Complete tabbing with one ribbon

m. All cables and cards included to be installed in Item 1.

1 ea. Quadram Microfazer Model #PWB-09-0053 Printer Buffer with the following specifications:

a. Parallel to parallel 64K buffer

b. Operate at 9 volts, .3 amps, and 2.7 watts

c. Includes all cables and cords, to be installed with Items 7 and 1.

2 ea. Microcomputer System Unit; Franklin ACE 1000 System with the following specifications:

a. 6502A Microprocessor with 8-bit CPU

b. 64K of RAM, 16K of ROM

c. Full keyboard with at least 63 keys but not more than 72, upper and lower case letters with auto-repeat, 40 characters per lines, 24 lines

d. 80 column card, color graphics and sound capabilities

e. Joystick game paddle connector, speaker and eight peripheral connector

f. One disk drive per package which contains 256K bytes of single sided storage 48 tpi, 300 RPM, 5¼" disk size, operate at both DOS 3.2 and 3.3

g. Cooling fan(s) and line surge protector(s)

2 ea. Dual Interface Cards for each of the two computers listed in Item 2

Two (2) serial (RS232) and parallel cards installed

2 ea. AMDEK Color II Monitor, Model No. 370JSB22 having the following specifications:

a. 13" screen, 90, in-line video RGB channels, TTL level (positive)

b. Horizontal Syne, TTL level (positive)

c. Vertical Syne (positive)

d. Resolution-horizontal 560 dots, vertical 240 TV lines

e. At least 7 colors and intensity (red, green, blue, yellow, cyan, magenta, and white)

f. Video cable to connect to Item 1

1 set Kraft Two Axis Control Sticks, Model #KJS-011 having the following specifications:

a. Stick (0) and stick (1) and the top (red) pushbutton (A-#1) is read using the strig (0) statement and function. The black pushbutton (A-2#) is implemented in a variety of programmable software.